REMARKS

Claims 1, 8, 11 and 12 are amended. Claims 1-16 are pending in the application.

Claims 1-3 stand rejected under 35 U.S.C. § 102(e) as being anticipated by Hasegawa, U.S. Patent No. 5,972,800. As set forth in the MPEP at § 2131, anticipation requires each and every element of a claim to be disclosed within a single prior art reference. Claims 1-3 are allowable over Hasegawa '800 for at least the reason that Hasegawa '800 fails to disclose each and every element in any of those claims.

As amended, independent claim 1 recites forming a nitrogen-comprising surface region layer across at least some of a silicon surface of a semiconductor substrate, the surface region extending no greater than 10 angstroms beneath the silicon surface. Independent claim 1 further recites after forming the nitrogen-comprising layer, growing an oxide region having a thickness of at least about 70 angstroms, the nitrogen of the nitrogen-comprising layer being dispersed within the oxide region. The amendment to independent claim 1 is supported by the specification at, for example, page 7, line 21 through page 8, line 5. Hasegawa '800 discloses introducing nitrogen into a silicon dioxide film (col 9, lns 41-46) and subsequently reoxidizing, resulting in an upper silicon dioxide film 2B and a lower silicon dioxide film 5 (col 10, lns 4-14). The Examiner states at page 2, section 1 of the present action, that Hasegawa '800 discloses growing an oxide region from at least some portion of the semiconductor substrate, the oxide region having a thickness of at least about 70 angstroms, and states reliance upon column 10, lines 15-25 of the Hasegawa '800 disclosure. The Examiner is mistaken.

Hasegawa '800 indicates at column 10, lines 19-20 that the silicon dioxide film 5 grown from the substrate has a thickness of 6 nm (60 angstroms). Accordingly,

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Hasegawa '800 does not disclose the claim 1 recited forming a nitrogen-comprising layer, and subsequently growing an oxide region from at least some of a semiconductor substrate, the oxide region having a thickness of at least about 70 angstroms. Additionally, Hasegawa '800 does not disclose the claim 1 recited nitrogen-comprising surface region layer across at least some of a silicon surface of a semiconductor substrate, the surface region extending no greater than 10 angstroms beneath the silicon surface. Accordingly, independent claim 1 is not anticipated by Hasegawa '800 and is allowable over this reference.

Dependent claims 2-3 are allowable over Hasegawa '800 for at least the reason that they depend from allowable base claim 1.

Claims 1-4 stand rejected under 35 U.S.C. § 102(e) as being anticipated by Wu et al., U.S. Patent No. 6,146,948. Wu discloses exposing an oxide portion over a substrate surface to a plasma to incorporate carbon into the oxide portion (col 3, lns 42-53). Wu further discloses that the plasma can additionally contain nitrogen which can be incorporated into the oxide portion along with carbon (col 4, lns 15-19), and/or incorporating nitrogen into the oxide region by nitrogen ion implantation (col 4, lns 36-40). Wu further discloses a subsequent thermal oxidation which produces an oxide portion 26A having a thickness of between 40 angstroms and 110 angstroms. The Examiner is reminded by direction to MPEP § 2131.03 that anticipation of a claim requires the reference to disclose the claimed subject matter with "sufficient specificity to constitute anticipation under the statute". Where no specific examples falling within the claimed range are disclosed in the reference, anticipation must be determined on a case to case basis. § 2131.03 further states that if the reference discloses a broad

range and the claims are directed to a narrower range, and there is evidence of unexpected results, it may be reasonable to conclude that the narrow range is not disclosed with "sufficient specificity" to constitute anticipation.

The range of oxide thicknesses disclosed in Wu is broad relative to the claim 1 recited minimum thickness of 70 angstroms. Wu does not disclose any specific examples of a grown oxide region having the claim 1 recited minimum thickness of 70 angstroms. Additionally, the claim 1 recited minimum thickness of 70 angstroms confers benefits relative to the cited art. As discussed in applicants disclosure at page 10, line 16 through page 11, line 4, forming the oxide layer to at least about 70 angstroms thick allows sufficient nitrogen dispersal such that nitrogen does not significantly affect performance of the oxide. As discussed, sufficient dispersal of the nitrogen can allow the oxide layer to be utilized as a gate oxide in transistor devices. Accordingly, the Wu disclosure does not anticipate the claim 1 recited subsequently grown oxide region having a thickness of at least about 70 angstroms, the nitrogen being dispersed within the oxide region. Additionally, Wu does not disclose the claim 1 recited forming a nitrogen-comprising surface region layer extending no greater than 10 angstroms beneath a silicon surface of a semiconductor substrate. Independent claim 1 is therefore allowable over Wu.

Dependent claims 2-4 are allowable over Wu for at least the reason that they depend from allowable base claim 1.

Each of claims 1-16 stand rejected under 35 U.S.C. § 103 as being unpatentable over various cited combinations of Hasegawa '800, Wu, Okumo (U.S. Patent No. 6,110,842), DeBusk (U.S. Patent No. 6,140,187), Ghidini (U.S. Patent No. 6,114,203)

and Hasegawa (U.S. Patent No. 6,091,109). The Examiner is reminded by direction to MPEP § 2143 that a proper obviousness rejection has the following three requirements: 1) there must be some suggestion or motivation to modify or combine references teachings; 2) there must be a reasonable expectation of success; and 3) the combined references must teach or suggest all of the claim limitations. Claims 1-16 are allowable over the cited combinations of Hasegawa '800, Wu, Okumo, DeBusk, Ghidini and Hasegawa '109 for at least the reason that each cited combination fails to teach each and every limitation in any of claims 1-16.

With respect to independent claim 1, as discussed above Hasegawa '800 does not disclose the claim 1 recited nitrogen-comprising surface region extending no greater than 10 angstroms beneath a silicon surface of a semiconductor substrate, or the recited subsequent growing of an oxide region from the semiconductor substrate, the oxide region having a thickness of at least about 70 angstroms and the nitrogen of the nitrogen-comprising layer being dispersed within the oxide region. Furthermore, Hasegawa '800 does not suggest the recited surface region extending no greater than 10 angstroms, or the recited oxide region having a thickness of at least about 70 angstroms. As further discussed above, independent claim 1 is not anticipated by Wu. Additionally, Wu does not suggest the recited nitrogen-comprising surface region extending no greater than 10 angstroms beneath a silicon surface. Since, as discussed above, the claim 1 recited oxide region having a thickness of at least about 70 angstroms confers specific benefits, the Wu disclosure does not suggest the recited 70 angstroms thickness (see MPEP § 2144.09).

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DeBusk teaches nitriding a thermally grown oxide layer to produce a nitride doped layer having a thickness of less than about 1.5 nm (col 3, ln 56 through col 4, ln 5). DeBusk does not disclose or suggest the claim 1 recited forming a nitrogen-comprising surface region extending no greater than 10 angstroms beneath a silicon surface and subsequently growing an oxide region having a thickness of at least about 70 angstroms, the nitrogen of the nitrogen-comprising layer being dispersed within the oxide region.

As noted by the Examiner at page 4 of the present action, Okumo does not disclose or suggest the recited oxide region having a thickness of at least 70 angstroms. Additionally, Okumo does not suggest the claim 1 recited forming of a nitrogen-comprising surface region extending no greater than 10 angstroms beneath a silicon surface of a semiconductor substrate.

Ghidini discloses forming a silicon oxide layer further comprising nitrogen having a thickness of from 6 to 35 nm (col 3, lns 1-2). Ghidini further discloses removing a portion of the silicon dioxide layer prior to nitriding and then reforming the oxide layer by subsequent oxidation treatment (col 3, lns 3-6). Ghidini does not disclose or suggest the claim 1 recited forming a nitrogen-comprising surface region extending no greater than 10 angstroms beneath the silicon surface. Further, as noted by the Examiner at page 7 of the present action, Ghidini fails to disclose or suggest the claim 1 recited oxide region having a thickness of at least 70 angstroms.

Hasegawa '109, as noted by the Examiner at page 10 of the present action, does not teach or suggest forming a nitrogen-comprising layer across at least some of a semiconductor substrate. Accordingly, Hasegawa '109 cannot teach or suggest the

claim 1 recited nitrogen-comprising surface region extending no greater than 10 angstroms beneath a silicon surface of a semiconductor substrate. Nor can Hasegawa '109 suggest the recited subsequent growing of an oxide region having a thickness of at least about 70 angstroms, the nitrogen of the nitrogen-comprising layer being dispersed within the oxide region.

As set forth above, not one of the relied on references teach or suggest the claim 1 recited forming of a nitrogen-comprising surface region extending no greater than 10 angstroms beneath a silicon surface of a semiconductor substrate. Additionally, none of the references teach or suggest the recited subsequent formation of an oxide region having a thickness of at least about 70 angstroms, the nitrogen of the nitrogen-comprising layer being dispersed within the oxide region. As combined, the various cited combinations of Hasegawa '800, Wu, Okumo, DeBusk, Ghidini and Hasegawa '109 fail to disclose or suggest the claim 1 recited forming a nitrogen-comprising surface region extending no greater than 10 angstroms beneath a silicon surface and subsequently growing an oxide region having a thickness of at least about 70 angstroms. Accordingly, independent claim 1 is not rendered obvious and is allowable over the cited combinations.

Claims 8 and 11 are amended to correct typographical errors. Dependent claims 2-11 are allowable over the various cited combinations of references for at least the reason that they depend from allowable base claim 1.

As amended independent claim 12 recites forming a nitrogen-comprising layer across at least some of a first oxide region and across at least some of a semiconductor substrate that is not covered by the first oxide region, the nitrogen-comprising layer

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extending less than or equal to about 10 angstroms beneath a surface of the first oxide region and extending less than or equal to about 10 angstroms beneath a surface of the semiconductor substrate not covered by the first oxide region. Additionally, independent claim 12 recites subsequently growing a second oxide region having a thickness of at least about 70 angstroms. Independent claim 12 is allowable over the various cited combinations of references for at least reasons similar to those discussed above with respect to independent claim 1.

Dependent claims 13-16 are allowable over the various cited combination of references for at least the reason that they depend from allowable base claim 12.

For the reasons discussed above, claims 1-16 are allowable. Applicant respectfully requests formal allowance of claims 1-16 in the Examiner's next action.

In addition to the amendments discussed above, applicant has submitted herewith a substitute drawing request to incorporate a correction of Fig. 6. As originally filed, the left sidewall of transistor 32 shown in Fig. 6 was mislabeled as "52" and should correctly be labeled "46", as set forth in the applicant's specification at page 12, lines 17-21. Applicant has amended Fig. 6 to correctly identify the left sidewall of the transistor 32 with the appropriate label "46". Accordingly, applicant respectfully requests formal acceptance of the substitute drawing into the file.

Respectfully submitted,

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Examiner ..... Pham, T.
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Title: Methods of Forming Oxide Regions Over Semiconductor Substrates

VERSION WITH MARKINGS TO SHOW CHANGES MADE ACCOMPANYING RESPONSE TO MAY 8, 2002 FINAL OFFICE ACTION

In the Claims

The claims have been amended as follows. Underlines indicate insertions and ~~strikeouts~~ indicate deletions.

1. (Twice Amended) A method of forming an oxide region over a semiconductor substrate, comprising:

forming a nitrogen-comprising surface region layer across at least some of a silicon surface of the semiconductor substrate, the surface region extending no greater than 10 angstroms beneath the silicon surface; and

after forming the nitrogen-comprising layer, growing an oxide region from the at least some of the semiconductor substrate, the oxide region having a thickness of at least about 70 angstroms, the nitrogen of the nitrogen-comprising layer being dispersed within the oxide region.

8. (Twice Amended) The method of claim 6 wherein the semiconductor substrate is exposed to the nitrogen species for a time of from greater than 0 minutes to about ~~about~~ 5 minutes.

11. (Twice Amended) The method of claim 9 wherein the semiconductor substrate is exposed to the nitrogen species for a time of from greater than 0 seconds to ~~about~~ about 30 seconds.

12. (Twice Amended) A method of forming a pair of oxide regions over a semiconductor substrate, comprising:

forming a first oxide region which covers only a portion of the semiconductor substrate;

forming a nitrogen-comprising layer across at least some of the first oxide region and across at least some of the semiconductor substrate that is not covered by the first oxide region, the nitrogen-comprising layer extending less than or equal to about 10 angstroms beneath a surface of the first oxide region and extending less than or equal to about 10 angstroms beneath a surface of the semiconductor substrate not covered by the first oxide region; and

after forming the nitrogen-comprising layer, growing a second oxide region from the at least some of the semiconductor substrate that is not covered by the first oxide region, the second oxide region having a thickness of at least about 70 angstroms.

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